PB 185979

X-RADIATION CONTROL PROGRAMS IN THE COLOR TELEVISION INDUSTRY

Summary Report on Visits to Manufacturers

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Consumer Protection and Environmental Health Service
Environmental Control Administration

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DIVISION OF ELECTRONIC PRODUCTS

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DEP 69-1

X-RADIATION CONTROL PROGRAMS IN THE COLOR TELEVISION INDUSTRY

Summary Report
on Visits to Manufacturers

May 1968 - December 1968

D.R.Smith, H.J.L.Rechen, D.J.Nelson,Jr.
Division of Electronic Products

March 1969

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Consumer Protection and Environmental Health Service
Environmental Control Administration
Bureau of Radiological Health
Rockville, Maryland 20852

Explanation of Division of Electronic Products Report Series

The Bureau of Radiological Health conducts a national program for the prevention and control of radiation hazards to man through (1) research and investigation activities into the effects and control of radiation emissions; (2) development of health and effects criteria and standards; (3) reduction of exposure from medical applications of radiation and reduction of population exposure from radioactivity released in the environment; (4) provision of program support to governmental and other agencies through technical assistance training programs, grants and contracts, and (5) the development of methodology for controlling exposures.

The Division of Electronic Products is the component of the Bureau responsible for studies intended to evaluate emissions of and conditions of exposure to electronic product radiation and intense magnetic fields. It develops and administers programs for testing procedures and techniques for minimizing radiation emissions from electronic products, such as microwave sources, ultrasonic devices, lasers, and color television receivers.

The Bureau publishes its findings in Radiological Health Data and Reports, the Environmental Health Series, Public Health Service numbered reports, appropriate scientific journals, and Division technical reports.

The numbered report series of the Division of Electronic Products (DEP) allow the results of Division and contractor projects to be published in a comprehensive form. The reports are distributed to State and local radiological health program personnel, Bureau technical staff, Bureau advisory committee members, libraries and information services, industry and industrial organizations, laboratories, the press, and other interested individuals. These reports are included in the collections of the Clearinghouse for Federal Scientific and Technical Information.

The readers of these reports are encouraged to comment on the reports. In some instances, additional copies of the report may be obtained from the Bureau.

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FOREWORD

The staff of the Bureau of Radiological Health (formerly the National Center for Radiological Health) from May 1968 to December 1968, visited facilities of 19 color television manufacturers to obtain information on industry programs for the control of X-radiation emission from components and receivers.

The tour of the production, engineering and research facilities, and programs for X-radiation control were arranged by the individual manufacturers and were indicative of the full cooperation of the domestic television industry. Each visit provided an opportunity for a free interchange of information. Procedures used by the manufacturer in measuring X-radiation from color television receivers, and the design measures taken to reduce or eliminate X-radiation emissions, were emphasized. During the visits wherever appropriate, the Bureau staff made recommendations on improvement of X-radiation measurement and control techniques.

Discussion with senior management, production, engineering, quality control and marketing staff during the plant visits, as well as first-hand observations of industry practices and procedures, provided data and information which should be helpful both in planning for and in fulfilling industry and government responsibilities pertaining to such product certification, standards, and enforcement activities as may be required under Public Law 90-602, "Radiation Control for Health and Safety Act of 1968."

Raymond T. Moore

Raymond T. Moore, M.D.
Acting Director
Bureau of Radiological Health

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INTRODUCTION

In December 1967 and January 1968, the Bureau of Radiological Health,* with the active cooperation of the Electronic Industries Association (EIA), conducted a survey of X-radiation emissions from color television receivers in the Washington, D. C. metropolitan area.[1] The purpose of the survey was to obtain information on X-ray emissions from home color television receivers of as many different manufacturers as possible. An earlier survey in Pinellas County, Florida,[2] designed to measure the effectiveness of a shunt regulator tube correction program instituted by one manufacturer, had indicated that radiation emissions were occurring from components common to all manufacturers, i.e., picture tubes, high voltage shunt regulator tubes, and high voltage rectifier vacuum tubes.

In the Washington study, some X-radiation emission was detected from 268 of the 1,124 color television receivers surveyed. Sets of 20 domestic and five foreign manufacturers were included in the sample surveyed. Six percent of the receivers exhibited X-radiation exposure rates above the 0.5 mR/hr recommended by the National Council on Radiation Protection and Measurements (NCRP).[3] Other surveys by State and local health departments have indicated a higher percentage of receivers with X-radiation exposure levels above 0.5 mR/hr.

Surveys, as well as laboratory studies,[4] have indicated that certain receiver design characteristics, namely shielding by structural materials or components, operating kilovoltage ranges, the choice of receiver components in the high voltate circuits, and circuitry permitting certain failure modes, were the important factors in controlling X-ray emissions from television sets.

X-ray survey methods used by representatives of receiver manufacturers during the Washington survey indicated that all factors in the measurement of X-rays were not being considered, and, therefore, the methods used were not adequate in all instances to insure that X-ray exposure levels in excess of the NCRP recommendations would be detected reliably during quality control procedures conducted on their receivers.[5] Moreover, a report of the Ad Hoc Advisory Committee on X-radiation from Color Television Receivers[6] to the Bureau, stated that Bureau efforts would be better expended on a program to assure compliance with the NCRP recommendation in future TV receivers instead of a program to locate X-ray emitting receivers already in homes. The reduction, control, or elimination of X-rays from home color television receivers by improvement of the product at point of manufacture is essential to certification of products

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*At the time of the survey, the Bureau was designated as the National Center for Radiological Health. The Bureau was established on December 20, 1968 as a part of the Environmental Control Administration.

under the Federal Radiation Control for Health and Safety Act of 1968, Public Law 90-602. At the invitation of the color TV manufacturers, visits were made to design, production, and research facilities in order to obtain information for consideration in planning for a continuing and effective program of X-radiation emission control by the television industry and for the protection of the consumer.

OBJECTIVES

The visit to individual manufacturers gave Bureau staff members an opportunity to discuss with management and production personnel steps taken by manufacturers to measure X-radiation from television components and receivers currently in production. In addition, plant visits made it possible for members of the staff to (1) review efforts being made in the design of current and future models of receivers for the reduction of X-ray emissions, (2) review available industry and Bureau of Radiological Health data relative to the specific sources of X-radiation characteristics of the products, (3) observe procedures used for measuring X-radiation from color television receivers and components under plant conditions, (4) observe research and development efforts related to color television X-radiation emissions, (5) discuss design and production changes necessary to reduce or eliminate X-radiation emissions, (6) review servicing procedures recommended by the manufacturer for receivers currently on the market, and (7) discuss voluntary manufacturer standards related to the control of X-rays.

CONDUCT OF VISIT

A letter was written in reply to each company's invitation outlining visit and discussion guidelines. A Bureau of Radiological Health (BRH) team was constituted in terms of technical background to insure that typical aspects of production, quality control, and engineering facilities could be competently reviewed during discussions and tours. Discussions during plant visits depended somewhat on the planned presentations, if any, made by each of the manufacturers. Bureau personnel, however, at some point in each visit, raised questions or sought information on company organization, quality control programs, component testing, engineering design and research related to X-radiation control tests and standards, servicing organizations, and factors in marketing and distribution required if correction programs should be necessary. Also discussed were import and export data, customer complaints, retrofits, and in-plant radiation control (Appendix 1).

At the time of the visit, names of individuals in the company responsible for administrative, engineering, and quality control functions associated with X-radiation emissions were obtained. Locations of principal production plants, quality control activities, and component manufacturing facilities of the company, and sources of components (picture, shunt regulator, and rectifier tubes) also were learned.

During the course of in-plant discussions, X-radiation data available for the models of receivers covered by the Washington area survey were reviewed. Current production data for these or subsequent models were obtained from some manufacturers. Research programs undertaken by the companies to identify sources of possible X-radiation, to evaluate components, and to measure X-radiation also were important considerations.

Efforts were made to determine the steps the manufacturers were taking or planned to take to reduce X-ray emissions from receivers and to maintain receivers without detectable radiation. X-radiation emission quality control procedures used by the manufacturer were carefully evaluated through observation of procedures practiced at each plant. Questions typically asked during the visits were:

How many sets were measured to determine the X-ray exposure levels from a particular production or model run?

What were the procedures for X-radiation measurement?

What radiation measurement records were maintained by the company?

What actions were or would be taken, and at what X-radiation exposure levels?

At each of the manufacturers' plants, it was considered important to learn what was being done either to decrease X-radiation emission levels or to control the use of X-ray emitting components in receivers. The discussions centered on what facilities and equipment were used for component testing and what criteria were used for acceptance of components. The manufacturer was asked to provide copies of the component testing results, if available.

The availability of engineering designs or future improvements the manufacturer could make to reduce X-ray exposure levels was of particular interest. Design features included high voltage control circuits, solid state circuits, improved cathode ray tubes, increased inherent shielding of components, external shielding of components, substitution of improved tubes or other easily replaceable components, and chassis shielding.

A production defect might require that the manufacturer be able to locate the purchasers of the products. To examine this possibility, the following questions were asked:

What were the current production and distribution projections for the various model receivers?

What methods were available to the manufacturer for locating receivers after market distribution, and have these methods been improved?

Had the manufacturer made plans for a modification or correction of currently marketed receivers which might exhibit measurable X-radiation emissions?

The discussion of the educational and servicing aspects of a manufacturer's operation provided an opportunity to identify the extent of instruction and training given service personnel regarding X-radiation emissions. Particularly important in this respect are (1) component replacement, (2) critical adjustments, i.e., operating high voltage, and (3) integrity of added shielding.

SUMMARY OF FACILITY VISITS

Since May 1968, Bureau representatives have visited color TV production facilities of 19 domestic manufacturers and seven related domestic component production facilities (Figure 1) (Appendix 2). A number of observations from these visits are summarized to give an understanding of the extent of X-radiation measurement programs carried on by the manufacturers.

Production:

The production of home color TV receivers reported by companies visited ranged from 100 to 6,000 per day. Production estimates obtained in this manner were substantially the same as the 5.5 to 5.8 million annual estimates quoted in, "Television Digest with Consumer Electronics."[7] Visits to the companies indicated that two basic chassis designs of color television receivers have been and are currently in production. One model contains a vacuum high voltage shunt regulator tube in addition to the high voltage rectifier and cathode ray tube (Figure 2). The other model is designed to operate without the shunt regulator tube. A third design, which substitutes a solid state device for the high voltage rectifier tube, is still considered experimental in the large screen models, but may soon be in extensive production.

Imports:

Eight of the companies visited import small screen black and white and/or color television receivers, or picture tubes. One domestic company manufactures large screen receivers for domestic sale under a foreign manufacturer's label. A second company reportedly was considering obtaining foreign designs for production. The manufacturing facilities of foreign manufacturers exporting color TV receivers to the United States were not included in the visit, and therefore, all imported models were not observed. Several imported chassis were observed to have unshielded high voltage components. In addition, domestic manufacturers did not always subject imported models to the same quality control procedures as are used for domestic models. It will be necessary to obtain additional information on imports and to determine X-ray quality control procedures for the imported receivers as well as for domestic home color television receivers.

Quality Control of Receivers:

Among companies visited, the percentage of TV receivers on which X-radiation measurements were made for quality control purposes ranged from 1% to approximately 10% of a day's production. X-radiation measurements were in most instances made on receivers selected for other observations or tests as a part of the normal production quality control sample. In no case did a manufacturer report that the X-radiation emission tests were a significant addition to the quality control costs. Seventeen of the companies visited used the Victoreen 440 RF portable ion chamber survey meter for their quality control (quality assurance) measurements with procedures adapted from the Joint Electron Device Engineering Council (JEDEC) publications[8,9] or Underwriters' Laboratories.[10] One company also uses the Public Health Service type X-radiation meter[11] for 100% screening of receivers. Three other companies were considering instruments of the Public Health Service design. In some cases, instrument readings were taken at specified locations on the receiver. In other plants, the instrument was moved slowly over the entire surface of the receiver.

X-radiation quality control measurements were made either during design or after production. Measurements of production models were made after adjustment of high voltage and user controls, as specified for normal operation, at a nominal line voltage, such as 120 VAC. Additional measurements on all six sides of the set with the line voltage elevated to 126, 130 or 132 Volts AC were included by the majority of the test programs. In all cases, records of X-radiation measurements were kept. In general, the procedures followed were either established as written company policy or followed those stated to be used by the Underwriters' Laboratories. Levels of X-ray exposure rates at which companies reportedly would take action, varied throughout the industry. However, levels such as 0.1, 0.15, and 0.3 mR/hr gross readings as measured by the Victoreen 440 RF survey meter, were mentioned. An individual authorized to take action, such as increasing production sampling, stopping production, or holding inventory, was identified in the organization of each manufacturer visited. In most cases, however, the individual responsible was not guided by specific written instruction or policy, but could exercise his judgment in determining the required action.

Quality Control of Components:

Sixteen of the 19 companies visited have outside sources of supply for high voltage shunt regulator tubes and high voltage rectifier tubes. Three companies produce their own high voltage shunt regulator and high voltage rectifier tubes. Six of the companies are their own suppliers of cathode ray tubes, although usually not exclusively. Another company obtains cathode ray tubes from a wholly owned subsidiary.

Each of the companies test components such as the shunt regulator and rectifier tubes in some manner, but not necessarily for X-ray production. The JEDEC procedures for these components were reportedly employed by five manufacturers of tubes, and by eight manufacturers of receivers.

Two other manufacturers of cathode ray tubes make X-radiation measurements on their tubes using procedures similar to, but not reported as, JEDEC procedures. Five other receiver manufacturers also make measurements on components for selection purposes, which although not stated as being JEDEC procedures, closely follow them. Records maintained by the companies show unshielded tubes measured in this manner with X-radiation output levels as high as 50 mR/hr.

New versions of high voltage shunt regulator tubes have been designed that incorporate features of lead enriched, heavier glass (as high as 49% lead oxide) and new anode and cathode designs within the tube to reduce transmitted X-radiation. Test data of component manufacturers have indicated that the X-radiation emission levels for new tubes have been drastically reduced by the thicker glass containing approximately 49% lead. High voltage rectifier tubes have been similarly improved, but not as predictably, by improved assembly procedures and by using thicker, lead enriched glass envelopes.

Two manufacturers of high voltage shunt regulator and rectifier tubes are developing production line testing machines which use Public Health Service developed circuitry with Geiger-Mueller tubes. This equipment is expected to measure and record X-rays from tubes while still in production at a rate approaching 750 per hour.

Daily lot tests and continuous samples of tubes are taken for X-radiation measurements from production at tube manufacturing plants. Measurements on the shunt regulator tube reportedly were generally made at 27.5 kV and 0.6 mA DC at 4.75 inches from the glass bulbs. A rejection level of 0.5 mR/hr on the full face of the 440 RF for the newer shunt regulator tubes was used by one manufacturer. The rejection level for the older versions of the shunt regulator tube was 10 mR/hr. The high voltage rectifiers were generally tested cold, with inverse voltage at maximum rating and reportedly were rejected at the 0.5 to 0.75 mR/hr level by one manufacturer. The component manufacturers reportedly have not established uniform criteria for rejection levels of the high voltage shunt regulator or rectifier tubes.

Within the last two years, the glass manufacturing companies have formulated new glasses to replace the funnel glass, tube face panels, and safety panels used during the earlier designs and production of cathode ray picture tubes. The cathode ray tube manufacturers have incorporated the

newer glasses as they have become available, but are limited in their choices by their assembly machines and the glass tints available. The new glasses for the face panels contain about twice as much barium as the older glass. The companies also are testing higher barium content glass (22% BaO) face panels. An improved funnel glass also is being tested by the companies. Tube face safety panels may be laminated with an additional layer of glass, principally for anti-glare and to obtain correct light transmission characteristics, as well as for improved safety from implosion. It was reported that a recently introduced safety panel glass and resin assembly was withdrawn from production after problems developed with unfavorable glass yields.

It was observed that the cathode ray tube manufacturers consider the following minimum steps necessary in the design of tubes and control of X-radiation emissions:

Control of Product - Make X-ray exposure rate measurements on new tube designs or modifications, including any new composition of glass, any new vendor's product, or changes in vendor's specifications, and routine sampling of the regular product.

Control of Glass Composition - Consult with vendor on proposed funnel and panel glass changes and review information supplied by the vendor on the linear X-radiation absorption coefficients of the glass.

Engineering Specifications - The cathode ray tube manufacturer has control of the bulb thickness specification. Deviations from specified bulb thickness by a glass manufacturer can cause the cathode ray tube manufacturer to reject the bulbs.

X-radiation from picture tubes was measured in accordance with JEDEC 648 using the Riverdale Precision TV-150 ion chamber and the 440 RF survey meter. Test procedures in the industry recently have been inter-compared by "round-robin" measurements of the minimum thickness picture tube.

At one cathode ray tube production facility X-radiation measurements were made on 19", 22", and 25" cathode ray tubes at 27.5 kV and 0.75 μA, the recommended maximum ratings. A 15" tube of slightly thinner glass, was tested at 22.5 kV, 0175 μA, also the recommended maximum rating. In addition to these tests, most of the cathode ray tube plants also tested to a factory specification of 35 kV and 300 μA (100 μA/gun) for 19", 21", 22", and 25" tubes, and 27.5 kV and 300 μA for the smaller tubes.

It was stated by cathode ray tube companies that X-ray emission characteristics of their products are available upon request but that the information is not furnished routinely to customers.

Design Engineering:

Design improvements of television receivers in many developmental stages were observed. These features include voltage control circuits, solid state rectifiers, and large size cathode ray tubes that are capable of operating at lower voltages. Other items under investigation are new designs of shunt regulator and rectifier tubes intended to reduce X-radiation emissions. In addition, improved chassis designs incorporating improved component shielding and features to prevent the adjustment of operating high voltage by unauthorized individuals were reported.

Labels:

Some type of warning label pertaining to possible X-radiation emission from the high voltage assembly and the cathode ray tube is displayed by the majority of the companies. The statement on the high voltage usually took the form of:

> "For proper operation, high voltage should be adjusted to rated voltage for receivers, no higher. Voltage higher than this limit may cause receiver damage or produce X-radiation hazard."

A second label calling attention to the possible hazard from shock and X-radiation if the high voltage enclosure cover was not kept closed during the receiver operation and servicing, was used by most manufacturers. The warning labels on the picture tube usually suggested the wearing of safety goggles to prevent possible injury from glass in case of tube breakage, and an X-ray warning for servicemen that shielding of the cathode ray tube may be necessary to protect against prolonged exposure to X-rays at close range.

Generally such labels were not placed on the outside of the receiver where they would be visible to the purchaser. Some receiver manuals, however, do contain statements to the effect that precautions have been taken for adequate X-radiation protection, and advise that under proper use the set is safe. Some labels request the customer, if service is required, to contact a serviceman qualified by the company to check or repair the receiver.

In-Plant Radiation Safety:

Thirteen of the manufacturers reported making in-plant surveys designed to measure X-radiation from possible sources such as test stands where high voltage tubes are activated. The surveys by ten companies include measurements made by film badges placed in engineering, production, and quality control areas. These companies reported film badge measurements have provided negligible readings. Two companies have, therefore, discontinued making film badge measurements. As part of the history of each

employee, it seemed advantageous for the company to maintain a record of each employee's exposure to ionizing radiation. Film badge readings would serve as a part of that record. In addition, a question on previous radiation history was asked during pre-employment physical examinations by a few companies.

Service Organizations:

The degree of organization and corporate control of color television receivers repair and servicing varied widely throughout the industry. About one-fourth of the manufacturers have no organized service program. The remaining companies to a varying degree maintain service organizations, in some cases nationwide, including authorized service, franchised dealers, company controlled or owned service companies, qualified service centers, and authorized retail store service representatives. All manufacturers provide service manuals either through their service organizations or for sale to servicemen. The service programs include training of servicemen, issuance of schematic drawings and other descriptive literature, and preparation and routine distribution of service bulletins and notes. Eighteen out of 19 of the manufacturers visited furnished servicemen literature, including some reference or advice on X-ray control. In most instances, this emphasized the need for proper high voltage adjustment for the receivers, preserving the integrity of shielding, and observing warnings regarding X-radiation. One possible deficiency in the servicing of color TV receivers is the accurate adjustment of the high voltage. Manufacturers could not assure that, either through training or by supply of equipment, the high voltage measuring probes, if used, were properly calibrated.

Location of Products:

Estimates of the percentage of receivers that could be located by warranty cards ranged from 30% to 99% for manufacturers that had a warranty card system. It was not possible to obtain an estimate from five manufacturers. The company which could locate approximately 99% of its original purchasers, but not transferees, was a kit company which either mailed the kits directly to customers, or retailed them from 14 stores. The warranties vary in type and duration, with the longer warranty, especially for cathode ray tubes, probably bringing the larger percentage return of cards. One of the largest manufacturers of TV receivers did not use warranty cards. The specific sales could be traced with some difficulty to dealers who then would be asked to locate receivers by general date code and chassis type.

OBSERVATIONS

Each of the companies visited had exhibited an awareness of the conditions that cause X-radiation emissions. Therefore, it is of interest to list some of the more important observations of the Bureau teams regarding industry programs for the control of X-radiation emissions from color TV receivers:

(1) The quality control techniques used did not seem to provide complete assurance that color television receivers being placed on the market were not exceeding the NCRP recommendation of 0.5 mR/hr in one hour on 10 cm^2 measured at 5 cm from any surface of the receiver. It was especially true when these procedures depended primarily on the use of the Victoreen 440 RF ion chamber survey meter, because of the limits on survey response time of the instrument and the possibility of missing small beams of X-radiation.

(2) It could be postulated that the companies which depended on added shielding to control X-radiation emissions could have a serious problem if designs were changed so that the shielding was inadvertantly removed from the X-ray generating tubes.

(3) Only one company had actually designed a shielding material for the anticipated X-ray exposure rate of the component which required shielding. Two other companies had designed a shielded socket for high voltage rectifier tubes. In a number of instances, the high voltage assembly was capable of emitting X-rays through perforations in the shield.

(4) The companies had limited control over the quality of the X-ray emitting components purchased from other manufacturers. The larger companies were beginning to exert some influence in this area through component testing programs and the X-ray emission specifications they are able to advertise for their components as a result of tests.

(5) It was observed that approximately 10 to 24 months were required to effectuate a production change in a receiver model. Rapid changes in external shielding were possible, but changes in tube types and circuitry required long periods of testing, including company acceptability tests, before they were put into effect.

(6) The ability of the manufacturer to conduct a program of modification in the field depended on the type of servicing and distribution system that he utilized. Most companies could locate approximately 60% of their receivers. However, the normal location capability ranged from 30% to 80%. A manufacturer of color TV assembly kits estimated it could locate approximately 99% of its receivers based on the return of warranty cards.

(7) The companies had not developed a reliable device to prevent adjustment of the high voltage to unusually high values. One receiver design had a diode voltage "hold-down" circuit which caused the picture to shrink, become unstable, and the high voltage to go down, if the shunt regulator tube failed. A number of manufacturers had limited access to the high voltage adjustment by placing a riveted shield over it or by removing the control.

(8) Components could be sold without manufacturer identification, even by EIA codes. Tubes might be custom labelled. Some were labelled, "Replace only with a genuine _____ tube." Obviously the user was not made aware of the need to replace the tube with one of low X-ray emission equivalent because the named supplier was free to change his source of components without having the label reflect the true manufacturer.

(9) High voltage on a number of receiver models can exceed 30 kV with the picture remaining viewable for indefinite periods. Values of excessive high voltage could result from high line voltage, improper service adjustments, failure of the shunt regulator tube and associated circuitry, or a combination of causes. In some receivers, excessive X-ray emission is prevented in the current production because chassis or component are shielded in sheet metal. At normal high voltage, excessive X-ray exposure rates might or might not be measured, depending on the quality of the tubes selected for high voltage rectifiers and shunt regulators and completeness of the shielding.

(10) No manufacturer revealed definite plans to utilize operating voltages higher than the currently specified voltages in new designs, but most reserved the right to exercise this option if research projects improved performance or reduced costs. An industry conversion to higher operating voltages, i.e., above 30 kV, will require a thorough review of existing X-radiation control programs and the existing industry standards for X-radiation emissions.

(11) Because X-radiation measurements were performed at nominal line voltage (120 VAC) some manufacturers did not know what X-radiation characteristics of their receivers would be under less favorable operating conditions. Tests performed by the manufacturers in the presence of Public Health Service personnel on some receivers at line voltages of 130 VAC (in some cases with the shunt regulator tube disabled) generally resulted in emission levels above 0.5 mR/hr at the face of the picture tube.

(12) Advice on proper high voltage setting in service manuals and warning labels pertaining to possible X-radiation emission from the high voltage assembly and the cathode ray tube give some assurance that field servicemen are aware of precautions to take regarding X-radiation emission.

(13) In a number of instances, it was not possible to determine, even after some discussion, whether or not a written policy had been issued to the manufacturer's key personnel stating the criteria to which receivers were to be designed, and from which quality control tests could be developed pertaining to X-ray control. Many manufacturers apparently permitted the quality control staff to develop their own action criteria, independently of the designers.

(14) In general, production companies placed reliance on parts suppliers and on available radiation data for selection of components. A few companies had made some measurements on rectifier and shunt regulator components for X-radiation emissions. However, they principally selected components

by engineering specifications. Generally, the testing of components for X-ray control was performed by the component manufacturers, if domestically manufactured components were used. A number of receiver manufacturers were beginning to exert their influence by performing quality control measurements on a number of components and by trying to obtain the best available components from an X-radiation standpoint.

(15) The companies, with the exception of the original shunt regulator tube modification program, have not developed programs to determine the status of receivers in the field or to correct those receivers that could be known X-radiation emitters. Even though new high voltage tube components and shielding have been developed, manufacturers are not incorporating them into receivers now in production or recommending their installation in receivers in the field. Delays may be attributed to (1) inadequate inventory of new components, (2) economic considerations due to large inventories of old materials and components, (3) requirements of engineering acceptability, (4) cost of production line changes, (5) lack of advertised specifications, (6) limited availability, (7) increased cost, and (8) lack of incentive to change. Therefore, sets will continue to be produced indefinitely according to the traditional program of production line X-radiation quality control. This will add to the number of receivers already in the field with the potential for excessive X-ray emissions.

(16) Visits to manufacturers have resulted in some additional points which should be considered more fully in future visits or inquiries, e.g., visits should be scheduled to the manufacturers who produce only components and who were not visited in conjunction with visits to receiver manufacturers. An effort should be made to obtain detailed information from foreign manufacturers of color TV receivers or components in view of the popularity of imported receivers and high voltage parts.

(17) About one-fourth of the manufacturers were aware of State regulations concerning radiation from television receivers. The other manufacturers assumed, they said, that, if they complied with Underwriters' Laboratories requirements, they would automatically comply with the State requirements.

(18) No company reported to us that there were justifiable complaints from their purchasers although they had numerous inquiries, nor that any type of retrofit appeared necessary, with the exception of advice to servicemen about high voltage adjustment, shielding placement, and perhaps return of early shunt regulator tubes.

(19) Inquiries of manufacturers concerning in-plant surveys should be considered in more detail in any future visit. Of the ten companies using film badges for surveys, no company reported finding significant X-ray exposure to plant personnel during design, production, or test procedures.

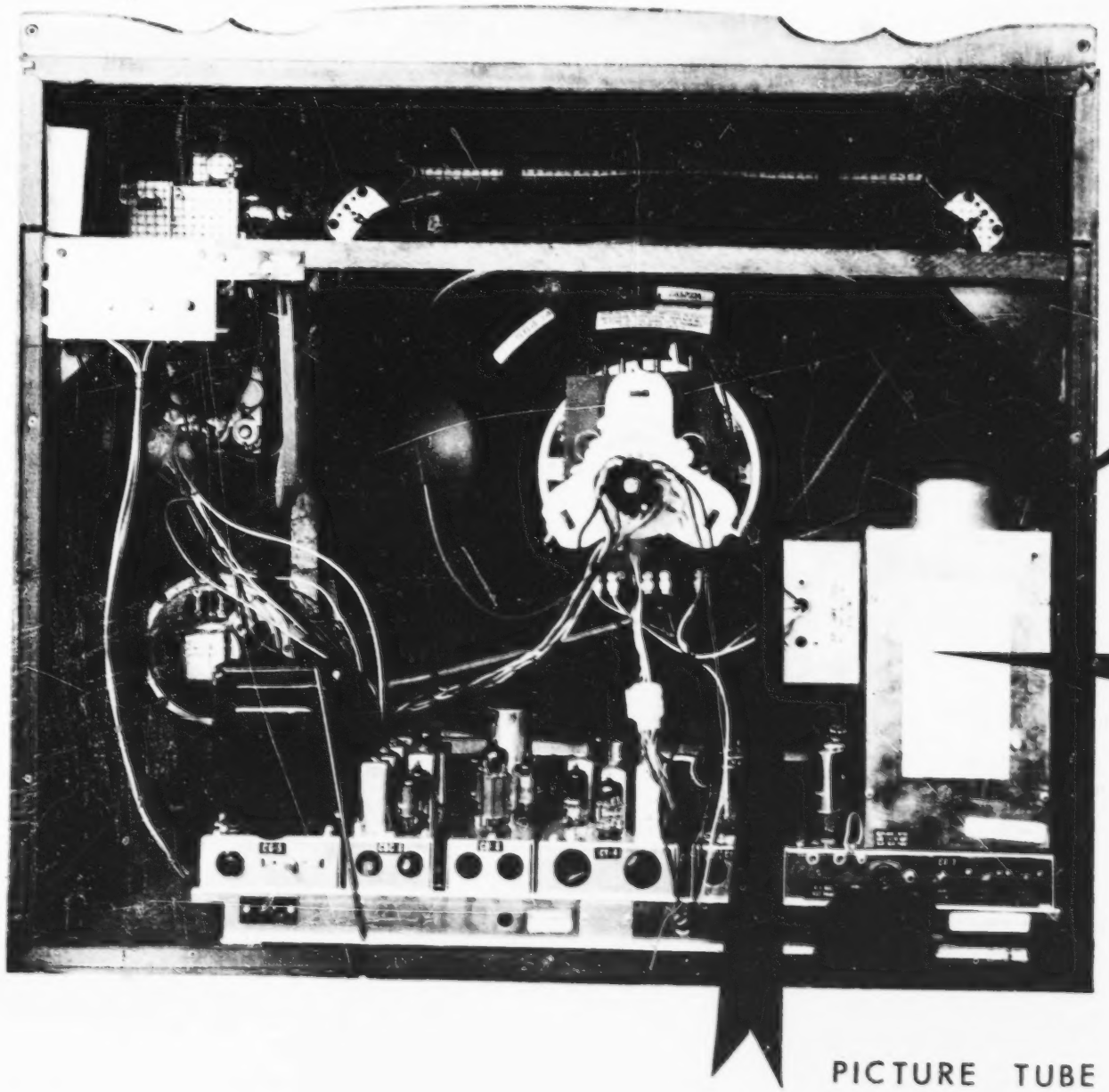
SUMMARY COMMENTS

Visits to the production facilities of 19 domestic manufacturers of color television receivers indicate the industry has taken a number of steps to control X-radiation emissions. There are identifiable and correctable deficiencies in the X-radiation emission control programs of the industry. Records of X-ray emission tests by the manufacturer at the factory indicate that receivers are being produced meeting the X-ray exposure control requirements established by the individual manufacturer. Additional evaluation and testing will be necessary before the purchaser of a color television receiver can be certain that there is no X-radiation exposure risk from the receiver under any condition of operation and service. It is recommended that efforts to achieve radiation-free consumer products be continued by both the television receiver industry and responsible government agencies.

COLOR TELEVISION PRODUCTION FACILITIES VISITED BY PUBLIC HEALTH SERVICE STAFF

● Receiver Assembly Plant
▲ Cathode Ray Tube Plants
□ Receiver Tube Plants
(Shunt Regulator, Rectifier)
○ Multiple Production Facility

Figure 1



SHUNT
REGULATOR
TUBE

RECTIFIER
TUBE

PICTURE TUBE

Figure 2

Appendix I

OUTLINE OF PROCEDURE FOR VISITS TO PLANTS

The following outline may be used by the Public Health Service representative to guide his discussions in meeting with the manufacturer, to take notes during the discussion, and to write the report of the visit:

I. Preparation for Discussion and Visit:

A. Company notification

Send letter outlining procedures and guidelines for visit. (Review files for previous correspondence.)

B. Review results from Washington, D. C. TV survey.

C. Review available technical information on sets manufactured by the company and on the components used in their fabrication.

D. Review previous reports on visits.

II. Conduct of Visit:

A. Organization and administration

1. Determine individuals in the company who are responsible for the various activities of interest.
Example: Quality Control and Engineering

2. Determine locations of final production plants and quality control facilities.

3. Procurement procedures:

a) Determine sources of components.

b) Determine location of plants which supply components.

4. Determine distribution system for final product.

B. Program Survey Data Review:

1. Review Washington, D.C. TV survey data with the manufacturer.

2. Determine whether the models showing radiation are still in production and obtain an estimate of the number of models on the current market.

3. Determine the company's current research activities in identifying sources of X-radiation in television receivers. Note the type of studies, i.e., radiographic film, spectral analysis, etc.

C. Review of Quality Control Program:

1. Determine where the facilities are located and what equipment is used for the program.

2. Determine what features are included in the program for protection of plant personnel.

3. Determine what facility or technique is used for calibration of radiation measuring equipment.

4. Specific features of quality control program:

a) Determine the number of sets tested per number of receivers produced.

b) Determine the procedures of measurements.

c) Obtain production estimates (if possible).

5. Determine whether quality control records are kept and obtain a copy of the record forms. Determine the procedure for keeping the quality control records.

D. Review of Component Testing Program:

1. Determine where the facilities are located and what equipment is used for testing components.

2. Determine the criteria used for acceptance of components.

3. Obtain component testing results and a copy of the testing procedure protocol.

4. Determine whether the company has a contract for independent audits of the quality control and component testing programs. If X-radiation measurements have been made by contract, obtain an identification of the contractor(s).

E. Engineering:

1. Identify the design features used to reduce X-radiation in new models.

2. Determine what modifications can be made to receivers currently on the market to reduce possible X-radiation emissions.

3. Determine the design features being incorporated or developed to reduce or prevent radiation emissions. Such features include high voltage hold-down systems, inherent shielding components, shielding of components, shielding by the chassis and the use of solid state circuitry as replacement of high voltage tubes.

4. Determine the ratio of shunt regulated and non-shunt regulated receivers currently in production.

F. Servicing Information:

1. Determine the company's organizational set-up for providing servicing of their sets.

2. Determine the nature and scope of the company's training program for servicemen.

3. Obtain copies of educational materials and bulletins used to inform servicemen of radiation hazards and safety precautions.

4. Determine whether labels or warnings are placed on the receiver regarding X-radiation emissions. Obtain samples of each type of label or warning device being used.

III. Summation with Management:

A. Obtain estimates for production and distribution of receivers.

B. Obtain information on the methods available to the manufacturer for locating receivers after market distribution.

C. Determine what in-plant safety programs pertaining to X-radiation from TV receivers are conducted by the company and whether each employee's radiation exposure history is obtained and maintained.

D. Determine whether the manufacturer has developed plans for correction programs, should the need arise.

E. Review the visit findings with the manufacturer prior to completion of the visit.

F. Inform the manufacturer of the findings and recommendations by letter within a reasonable time period after completion of the visit.

Appendix II

VISITS TO MANUFACTURERS OF TELEVISION RECEIVERS

Manufacturer and Location	Date of Visit	Type of Plant
Zenith Corp. Chicago, Ill.	May 24	Research, Engineering and Production (Quality Control)
DuMont Emerson Jersey City, N. J.	July 18	Research, Engineering and Production (Quality Control)
Setchell-Carlson St. Paul, Minn.	Aug. 7-8	Research, Engineering and Production (Quality Control)
Philco-Ford Phila., Pa.	Aug. 19	Research, Engineering and Production (Quality Control)
Magnavox Fort Wayne, Ind.	Aug. 21	Research, Engineering and Production (Quality Control)
Magnavox Greenville, Tenn.	Aug. 22	Production Facility (Quality Control)
Warwick Forrest City, Ark.	Sept. 12	Engineering and Production (Quality Control)
Warwick Chicago, Ill.	Sept. 13	Engineering Design
Wells-Gardner Chicago, Ill.	Sept. 13	Engineering and Production (Quality Control)
Hoffman Orleans, Ind.	Sept. 19	Production (Quality Control)
Admiral Chicago, Ill. Harvard, Ill.	Sept. 20	Engineering, Production and Cathode Ray Tubes (Quality Control)
Packard Bell Los Angeles, Calif.	Sept. 26-27	Engineering and Production (Quality Control)

Manufacturer and Location	Date of Visit	Type of Plant
Curtis-Mathes Athens, Texas	Oct. 15	Engineering and Production
Philco-Ford Lansdale, Pa.	Oct. 17	Component and Cathode Ray Tube Plant
RCA Harrison, N. J. Woodbridge, N. J. Somerville, N. J.	Oct. 18	Component Plants
General Electric Syracuse, N. Y. Owensboro, Ky.	Oct. 21-24	Production, Engineering and Components (Cathode Ray Tubes and Receiver Tubes)
Westinghouse Edison, N. J. Elmira, N. Y.	Oct. 28-29	Production, Engineering and Components (Cathode Ray Tubes and Receiver Tubes)
Sylvania Batavia, N. Y. Seneca, N. Y.	Nov. 6-8	Production, Engineering and Components
Motorola Chicago, Illinois	Nov. 18-20	Engineering, Production and Components (Cathode Ray Tubes)
TMA (Muntz) Wheeling, Illinois	Nov. 20	Production and Engineering
Olympic Glendale, N. Y. Long Island City, N. Y.	Dec. 5	Production and Engineering
Heath Company Benton Harbor, Michigan	Dec. 9-11	Engineering and Assembly

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